Development of Learning Media of Metal Casting Sand Casting Method Based on Virtual Laboratory for Increase Creative Skill

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Abstract: Practical learning at Vocational High Schools (SMK) before the Covid-19 pandemic has left a problem, namely a lack of competence. In particular, in the metal casting practicum using the sand-casting method, students still have many difficulties in recognizing and using the tools and materials found in the laboratory. This study aims to develop learning media for metal casting using the virtual laboratory-based sand-casting method. The development model used is the waterfall software development model. The steps contained in the development of this model consist of (1) analysis of material requirements, practical equipment, occupational safety and health equipment and users; (2) product design in accordance with the results of the previous analysis; (3) Coding of the developed learning media. This coding requires Unity 3D software. Last is (4) testing. The results obtained with the application of sand casting learning through virtual laboratory reality are able to increase the value of critical and creative thinking skills.

INTRODUCTION

Basically, casting with sand is used to process low temperature metals, such as iron, copper, aluminum, magnesium, and nickel. Casting with sand can also be used for high-temperature metals, but metal materials other than that cannot be processed. This casting is the oldest and most understood technique to date. These forms must be able to satisfy certain standards because these forms are the essence of the casting process with sand (Widarto, 2008).

With the Covid-19 pandemic and the enactment of learning that is not optimal, it will have a very bad impact on the competence of Vocational High School students with the competence of casting engineering expertise. It should be noted that the development of temporary metal casting learning media is still limited to macromedia flash interactive learning media developed by (Anam and Wibowo, 2018). And no one has created and developed learning media for metal casting techniques based on virtual laboratory. Even though if we look ahead, the existence of virtual laboratory in the field of welding is accepted by workers who are currently in the training period (Papakostas et al., 2021b).

Virtual laboratory-based learning media is defined as learning media that is able to provide ideal interfaces by utilizing the internet of things (IOT) (Papakostas et al., 2021a). This application serves to present information about smart objects and services that are connected to the user's view in real time (Amin and Govilkar, 2015)(Bocevska, 2016).

Critical thinking skills are the ability to use the mind to find meaning and understanding of something, explore ideas, make decisions, think about solutions with the best considerations and revise problems in the previous thinking process (Alias, 2015). Critical thinking skills are the main skills that are expected to be possessed by 21st century humans (Jerald, 2009; Thompson, 2011). Critical thinking skills are defined as the ability to analyze the data obtained, evaluate the actions to be taken (Simpson and Courtney, 2002), and produce the right decisions (Addy and Stevenson, 2012). Beyer (1995) states that critical thinking skills are abilities that can determine the credibility of a source, distinguish between relevant and not, distinguish facts based on assessment results, identify points of view and evaluate the evidence offered to support recognition. Critical thinking skills are related to the problem-solving process (Friedel, 2008) that can occur in life, work, and all other aspects of life (Slameto, 2014). Based on the explanation, it is important to prepare critical thinking skills for the younger generation so that they can be successful in their chosen education and work.

Creative thinking is the ability to create an idea, find many possible answers to a problem, make new combinations based on existing data, information or elements. Creative thinking (divergent thinking) is the ability to think based on available data/information and find many possible answers to a problem; where the emphasis is on quantity, appropriateness, and diversity of answers (Munandar, 2008). Some experts argue that: (1) creative thinking is related to something new and valuable; (2) creative thinking covers all aspects of life; (3) creative thinking is different from intelligence abilities, meaning that even though high intelligence is not necessarily creative and vice versa; and (4) everyone has the potential to be creative if they are spontaneous and open (Rothenberg and Hausman, 1996).

Efforts to improve competence in students continue to be developed. One of them is by applying virtual laboratory learning. virtual laboratory is the result of technological developments within the scope of education (Pramono & Setiawan, 2019). One of the results of this technological development serves to bring something that was previously difficult to access into something that is easy and accessible. In its application, virtual laboratory can combine virtual objects both 2 and 3 dimensions into the real environment through projection results. Soepriyanto & Rahmatullah (2017) added that this media really helps the academic environment in presenting material virtually.

METHODS

The type of data used is quantitative data. The data is obtained from the test results. The test results of the two groups were tested using the t-test statistical test. The use of t-test aims to determine the level of significance and average results between the control group and the experimental group. Before the t-test was conducted, a pre-requisite analysis test was conducted, namely the data normality

test and the homogeneity test between groups. Statistical calculations were carried out with the help of the SPSS 20.0 for windows program.

Quantitative data analysis in this study used descriptive statistics and inferential statistics. Descriptive analysis technique is used to analyze test results to measure critical thinking and creative thinking skills. The technique used in the descriptive analysis is based on the average score of each test group. Next is inferential statistics through t-test. Data from the research on critical thinking and creative thinking skills will be analyzed using t-test at a significance level of 0.5%. Prior to the statistical test, the analysis prerequisite test was carried out. The prerequisite test includes normality test and homogeneity test.

RESULTS AND DISCUSSIONS

Analysis of students' critical and creative thinking skills through virtual laboratory-based learning, obtained the following results.

Descriptive Analysis

Critical Thinking Ability

The average test results of the control group's critical thinking skills were 59.82 while for the experimental group it was 67.61. From the results of the critical thinking ability test, the minimum score for the control group was 46 and the minimum score for the experimental group was 42. The maximum score for the control group was 79 and the maximum value for the experimental group was 78. The following is a comparison distribution diagram between the control group and the experimental group.

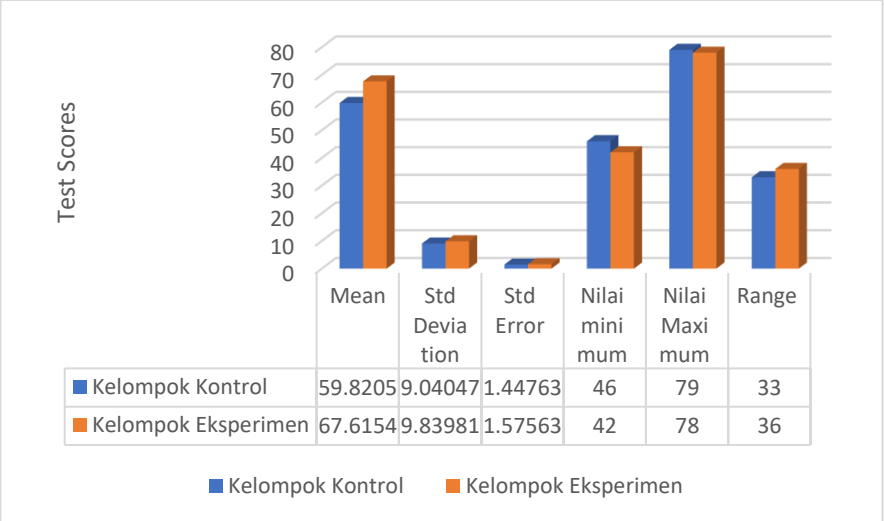

Figure 1. Distribution Diagram of Comparative Test Scores Critical Thinking Ability Control Group and Experiment Group

Based on the results shown in Figure 1, it can be concluded that there is a significant/significant difference between the control group and the experimental group in the maximum value of critical thinking ability results.

Creative Thinking Ability

The average result of the control group's creative thinking ability test was 83.18 while for the experimental group it was 88.20. From the results of the creative thinking ability test, the minimum score for the control group was 63 and the minimum score for the experimental group was 73. The maximum score for the control and experimental groups was 100. The following is a comparison distribution diagram between the control group and the experimental group.

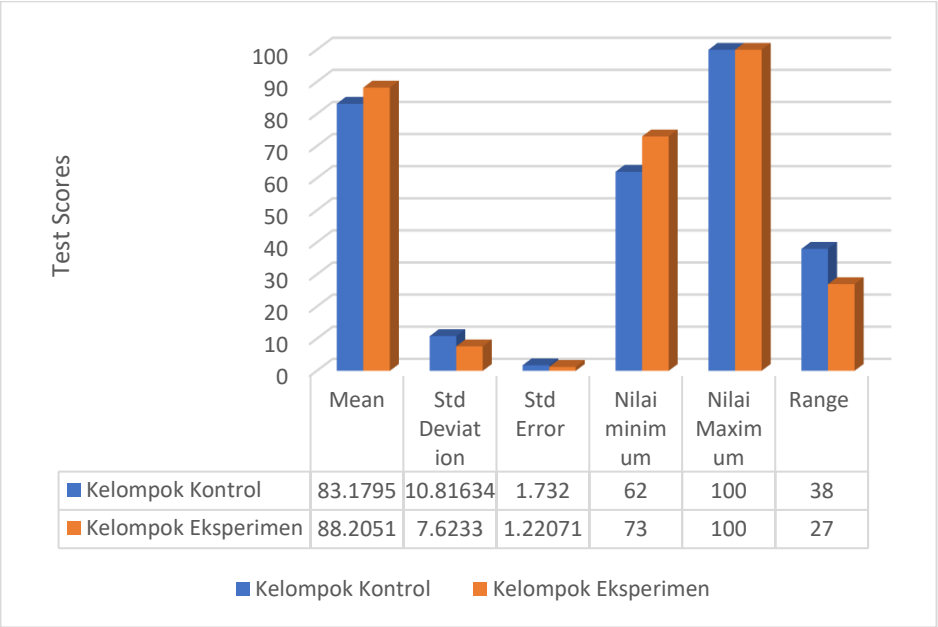

Figure 2. Distribution Diagram of Comparative Test Scores Creative Thinking Ability Control Group and Experiment Group

Based on the results shown in Figure 2, it can be concluded that there is no significant/significant difference between the control group and the experimental group on the maximum value of creative thinking ability results.

Inferential Analysis

In inferential statistical analysis, the data obtained must meet the prerequisite analysis test. The analysis prerequisite test includes normality and homogeneity tests. After passing the two types of prerequisite tests, then the next t-test is carried out. The following are the results of the normality, homogeneity, t-test which are presented sequentially in Tables 1,2, and 3.

Table 1. Normality Test Results

Variable	Test results	Criteria Sig.	Conclusion
Critical thinking	0,197	>0,05	Normal
Creative thinking	0,744	>0,05	Normal

The test criteria are concluded if the test results show Sig > 0.05, then it is concluded that the data is normally distributed. Based on the data in Table 1, it can be concluded that the variables of critical thinking ability and creative thinking have

a significance score > 0.05, so it can be concluded that the data is normally distributed.

Table 2. Homogeneity Test Results

Variable	Test results	Criteria Sig.	Conclusion
Critical thinking	0,736	>0,05	homogeneous
Creative thinking	0,085	>0,05	homogeneous

The test criteria are concluded if the test results show Sig > 0.05, then it can be concluded that the data is homogeneous or the same. Based on the data in Table 2 shows that the variables of critical thinking and creative thinking have a significance score > 0.05, it can be concluded that the data comes from a population that has the same variance or is homogeneous.

Based on the results of the pre-requisite analysis test, namely the data normality test and the homogeneity test between groups that have been carried out statistical tests can be continued on the T-test.

Table 3. *T-test* results

Variable	Test results	Criteria Sig.	Conclusion
Critical thinking	0,000	<0,05	There is a difference
Creative thinking	0,020	<0,05	There is a difference

The criteria used in the t-test state that H_0 is rejected if Sig < α and H_1 is accepted if Sig > α. Based on the results of the t-test presented in Table 3, several conclusions were obtained, namely as follows:

a) There is a significant difference between the results of critical thinking skills in the control class and the experimental class (H_0 is rejected and H_1 is accepted).
b) b) There is a significant difference between the results of creative thinking skills in the control class and the experimental class (H_0 is rejected and H_1 is accepted).

The low critical thinking ability can be caused by content-based learning. Content-based learning tends to make students only remember knowledge rather than analyzing and synthesizing the meaning of knowledge, so that it can reduce critical skills and problem solving (Othman, et al, 2008; Shakir, 2009). Low critical thinking skills can also be caused by these skills being rarely taught explicitly (Addy, 2012), while various 21st century skills must be taught explicitly (Zubaidah, 2016).

The significance of the results of the t-test on critical thinking skills shows the number 0.000 so it can be concluded that there is a significant difference between the results of critical thinking skills in the control class and the experimental class.

Next in terms of the ability to think creatively. Creative thinking ability is an individual's ability to find new ways, strategies, ideas or ideas how to get a solution to a problem at hand (Moma, 2017). Creative thinking is not making something that doesn't exist, but the ability to generate new ideas by making combinations, making changes, or applying existing ideas to different areas. The

low ability to think creatively is caused by lectures that emphasize more on manipulative skills or how to do something but less on why it is so and what the implications are. In other words, the learning process is only in the form of rote memorization, not problem solving, reasoning, critical thinking, and creative thinking (Fahinu, 2007; Sumarmo, 2002).

The significance of the results of the t test on creative thinking ability shows the number 0.020 so it can be concluded that there is a significant difference between the results of creative thinking skills in the control class and the experimental class.

CONCLUSION

Sand Casting learning through virtual laboratory has been successfully applied. The results obtained with the application of sand casting learning through virtual laboratory reality are able to increase the value of critical and creative thinking skills. It is also known from the results of the t-test which shows a significant difference between the control and experimental groups.

SUGGESTION

Sand casting practicum learning through virtual laboratory needs to be disseminated in all Vocational High Schools. In addition, it is also necessary to develop other types of practicum in machining fields an example is welding.

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